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AN APPLICATION OF INTEGRATED HUMAN RESOURCE PLANNING SUPPLY-DEMAND MODELS

BY

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An integration of external supply and internal demand human resource planning models is required to answer the wider questions posed by the U.S. Navy's growth in the 1980's. Such a model system is illustrated in this paper by means of a study of the impact of technological and economic change on the Navy's requirements for civilian physical science and engineering technicians in the 1980's. The results of the study are used to show how the system could be extended to additional occupations such as ~~skilled craftsmen and engineers~~ which would be affected in the expansion to a 600 ship Navy.

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by

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(Manpower and Reserve Affairs)

July 1981

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Introduction

The U.S. Navy's increasing reliance on complex technology creates higher requirements for skilled military and civilian technicians to maintain the resulting hardware systems. The Navy's planned major expansion will increase both the quantity and skills required in its civilian work force. At the same time there is a rapidly expanding demand for skilled technical manpower in the civilian economy. When increased Navy and Civilian economy demands are compared with the reduced supply resulting from changing demographics, questions arise as to how the Navy will meet its future civilian and military manpower requirements. Existing human resource planning models allow prediction of internal demand and more recently developed econometric labor supply models allow prediction of external supply. An integration of these external supply and internal demand models is now required to answer the wider questions posed by the Navy's projected growth in the 1980's.[1]

The model system discussed in this paper is illustrated by means of a study of the impact of technological and economic change on the Navy's requirements for civilian physical science and engineering technicians in the 1980's. Within this target group male, female, minority and non-minority categorizations are also included so that the equal employment opportunity (EEO) implications of the study could be considered. The results of the study are used to show how the system could be extended to additional occupations such as skilled craftsmen and engineers which will be affected in the expansion to a 600 ship Navy.

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[1]See chapter 10 of R. J. Niehaus, Computer Assisted Human Resources Planning, (New York: Wiley Interscience, 1979) for a discussion of the issues of integrated human resource planning systems.

Background

Human resource planning (HRP) models have been used for Navy civilian workforce planning since the late 1960's.[2] These models have concentrated on internal organizational factors: projecting the workforce forward over a multi-period planning horizon from the initial on-board population, with predicted rates of movement between categories, towards requirements that may vary over time. Hires, fires, promotions, and transfers can be chosen by the models to come as close as possible to planned requirements, subject to a series of organizational constraints. Although it is possible to include consideration of external factors in this approach through their effect on hiring constraints and personnel movement rates, these effects had not previously been estimated at the level of detail needed for Navy HRP models.

In another area of research, the Navy has been conducting extensive labor market analysis to support its EEO effort.[3] Geographic labor markets that supply the Navy with civilian personnel have been defined for each occupation, level, and Navy activity. Econometric labor supply analysis techniques based on reservation wage concepts have been developed to estimate the available supply of qualified and qualififable personnel for each occupation and level, in each race, national origin, and sex category for the Navy's labor markets. Recent extensions of the econometric models discussed in this paper include variables that allow assessment of the impact of alternate demographic trends and economic scenarios upon labor supply availability. These econometric labor supply

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[2]See A. Charnes, W. W. Cooper, and R. J. Niehaus (8).

[3]See Atwater, Niehaus and Sheridan (2) and (3).

models now need to be brought together with HRP models to form integrated model systems that consider both internal organizational demand and labor market supply forces in determining the impact of external conditions upon organizational human resource planning.

The initial approach to this integration has concentrated on the effects of technological change on the Navy's ability to meet its civilian manpower requirements. An example has been constructed that predicts flow rates between the Navy's physical science and engineering technicians, its blue collar craftsmen, and external labor markets under three economic/technological scenarios. The example produces recruiting requirements for technicians and craftsmen over a seven year planning horizon, 1980-1987, using various historical data from the 1970-1979 period. Three alternative economic scenarios were used: a base (nominal technological and "average" economic conditions) projection; a low private sector wage projection; and a high private sector wage projection. The results indicate that the Navy will have to hire increasing numbers of technicians under all three cases to meet requirements fixed at current levels. The nominal and high wage scenarios require hiring substantially more technicians than the observed maximum over the last five years. Even the low wage scenario causes this level to be exceeded.

The initial approach can now be carried forward by extending both the methodology and the application of the initial example. The econometric models need to be extended to estimate the maximum number of hires the Navy could reasonable expect to bring on-board. These estimates would then be used as hiring constraints in the internal HRP model. The current example considers the supply from the internal labor market - the extension brings in the external labor market supply as well. The HRP side of the model can be extended to include flexible flow

rates between selected occupations to allow better evaluation of upward mobility strategies into the critical occupations. Thus the "make or buy" question may be quantitatively addressed if there are not enough trained individuals in the external labor market (who are wage available) to meet Navy requirements.

The application of the example could be expanded to include other occupations involved in expanded technology and growth of the 600 ship Navy. Engineers and computer specialists would be among the occupations directly impacted by technological change. Blue collar craftsmen were used in the initial example as a source for migration into the technician occupation since data shows this group as the largest internal source. Lower level managers and administrators and clerical personnel are other sources for migration into the technician occupation at lower grades. These occupations would also be included in the expanded study.

System Design

The design of a system of human resources supply-demand models draws on two very large bodies of knowledge. The models developed for the U.S. Navy civilian work force parallel those which would be used for private industry. On the supply side, econometric models are used to estimate wage availability. On the demand side, flow models are used to determine the numbers of persons to be recruited in specific job categories. The supply side and the demand side are linked by the flows into and out of the organization. A simplified flow diagram of the supply-demand model system is provided in Figure 1.

HUMAN RESOURCE PLANNING SUPPLY-DEMAND MODELS

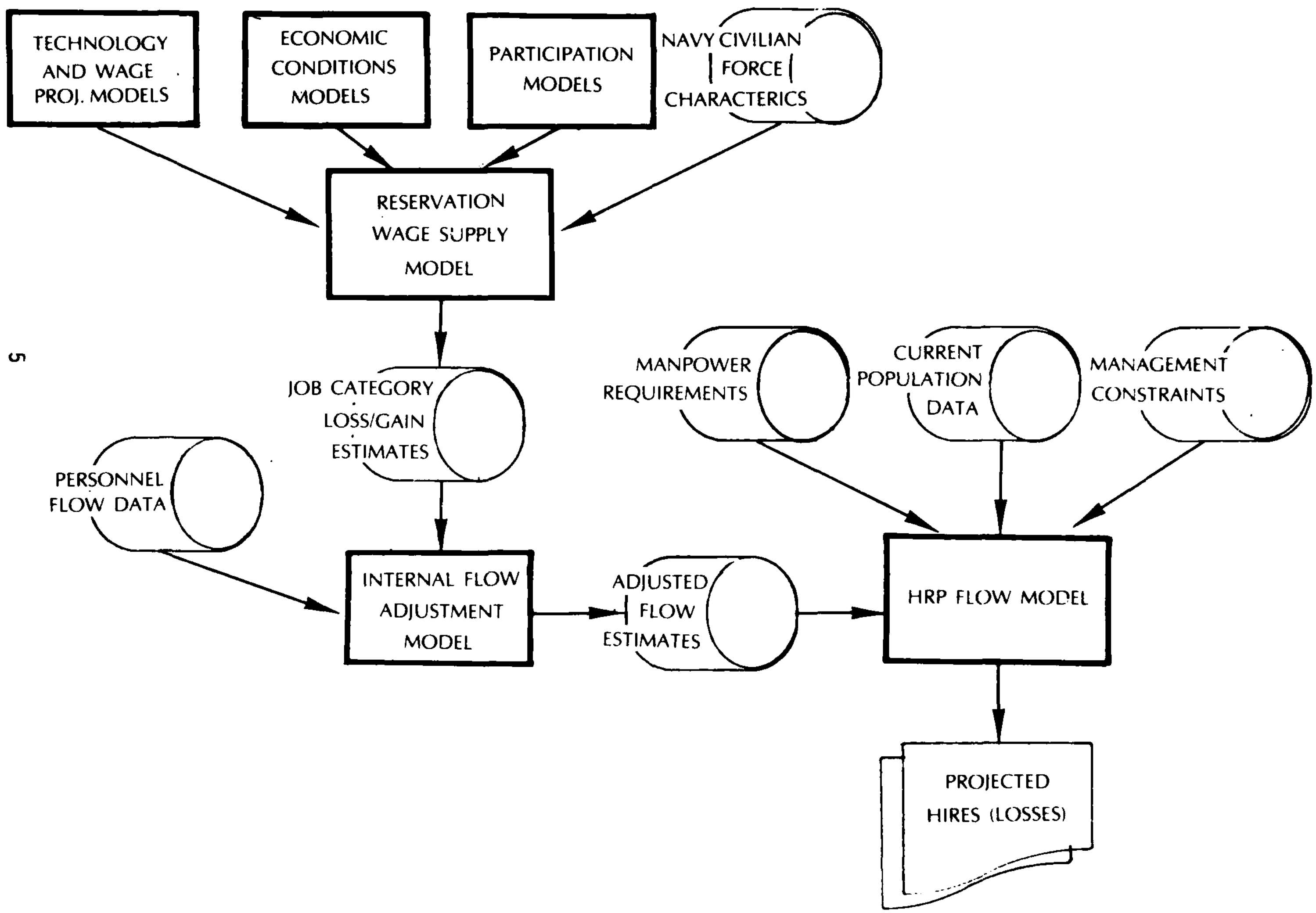

Figure 1

A reservation wage supply model is used to estimate worker availability for specific skill or job categories. The reservation wage is defined as the minimum wage needed to attract a person to begin work in a defined job. The method assumes that a person will make work choice decisions strictly on the basis of offered wages and the value of his leisure time.[4]

There are four major inputs to the reservation wage supply model. Each comes from a complex model or a management information system data. reduction process. The technology and wage projection models and economic conditions models are used to develop the value of wage economic incentives. The participation models are used to develop the value of wage economic incentives for selected job opportunities in the future. The Navy civilian force characteristics are obtained from internal management information systems such as the Personnel Automated Data System (PADS).

The reservation wage supply model is used to estimate the losses/gains to job categories under different scenarios. These data are used in an internal flow adjustment model to revise personnel flow estimates to reflect the level of loss rates to the external economy with alternative external scenarios.

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[4] See Atwater and Sheridan (4) for a discussion and references on the reservation wage methodology.

A standard human resources planning flow model is used to estimate projected hires (losses). Inputs to the HRP flow model are the adjusted personnel flow estimates, manpower requirements, current on-board population, and management constraints such as a budget and personnel ceilings. Equal employment opportunity considerations can be included since the input data can be estimated by race or national origin and gender category.

<u>Econometric Labor Supply Modeling</u>

The econometric labor supply modeling approach corresponds to the top half of Figure 1. It provides both a new method for the development and analysis of economic incentives across multiple job sectors and occupations and an integrated perspective between macro economic factors and work decision behavior modeling at the micro level. The approach is still developmental in nature and is expected to undergo numerous enhancements in the future.[5]

The development of accurate and comparable economic incentive measures (i.e. wages) is a principal concern in the approach. The econometrics focus on disaggregating or unbundling the dynamics of compensation into a sector component, an occupation component and a job component. The sector component is linked to specific macro economic conditions (i.e. unemployment, GNP, interest rates and inflation) and to alternative views of technology and forecasted events. The occupation component is core around which public data (i.e. Census data, etc.) on multiple job options can be tracked and projected into the future periods. The interactions of the occupational employment and

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[5] The model mathematics can be found in D. M. Atwater, E. Bres III, R. J. Niehaus, and J. A. Sheridan (1).

occupational wage process over time provide a basis or foundation for integrating the sector and job specific information. A multi-tiered recursive modeling format is used. The job component analysis is required to align the more aggregate compensation information with special skill factors and for work and leisure.

The economic incentives include both work and leisure wage measures. The value of leisure time is calculated using a proven and tested reservation wage modeling sequence. The reservation wage modeling takes into account sampling selectivity bias modifiers and is structured to develop labor supply information at the sector/occupation/job level for selected race or national origin and sex groups. The three economic behavior decision models compare reservation wages and market wage alternatives which persons must choose between when comparisons of work opportunities across jobs, occupations, and sectors are considered.

The economic labor supply modeling methodology is extremely flexible in terms of the range of events and decisions which can be examined. Wherever appropriate, cyclical conditions have been included using residual regression techniques. Decision choices have been analyzed using probit analysis to reflect dichotomous behavior options. Constant dollar measures are used to avoid errors in forecasting due to real wage tradeoffs. Most importantly a wide range of control variables are provided to examine alternative views of the future. All of the econometric relationships are linked together in a balanced, dynamic structure which is sensitive to change but, based on testing, is not prone to instability.

The economic decision models are based on specific comparisons of reservation and market wage measures for current jobs and selected alternative work options. Information on persons in the selected race or national origin and sex groups, and information on jobs in defined sectors and occupations, was used in the estimation of the reduced form and structural participation models. The economic incentives were then calculated for the targeted Navy civilian forces and their supply decisions quantified. Projections of supply decisions were made using three discrete views of future technology and the economy of the United States in the period from 1980-1985. The control factors used in defining the scenarios were:

- Annual Wage Earnings
- Hours Worked Schedules
- Inflation (CPI)
- Gross National Product
- Prime Interest Rate
- Unemployment
- Wage Growth
- Employment Growth
- Time (Year)
- Capital Expenditures

Within the context of the labor supply modeling system selected Navy civilian work force profiles were calculated for each year in the period.

The economic and technological factors are quantified at alternative levels to yield scenario definitions. As listed in Figure 2 three views or scenarios have been developed to represent the range of possibilities for projection of science and engineering technician losses and gains.

The BASE scenario trends the patterns observed for the historical period (1972-79) and uses the realistic or most likely forecasts for macro economic conditions. Another title for this scenario might be the "status-quo" view. The HIGH TECHNOLOGY view focuses on high inflation and general unemployment with rapidly rising private sector economic incentives and higher than usual job movements. Also the relative earning position of craft jobs in the Navy Civilian sector increases when compared to technicians wages. This scenario is appropriately considered the worst case view.

The best case view is the LOW TECHNOLOGY scenario. Here the relative position, movement and ranking of the Navy civilian technician wages exceed the comparable private sector wages. Craft journeymen are also pulled into the available pool in large numbers.

The productivity citations refer to the dynamics of the employment process. Where productivity is high, levels of output increase more rapidly (per standard work unit) and thereby technicians differential wages increase more rapidly.

The technology (introduction of equipment/jobs) is also an important qualifier because it reinforces the productivity and employment selection process. With more employment opportunties private sector losses will increase and frictional unemployment (i.e. switching between jobs by workers) is likely to escalate.

SCENARIO DEFINITIONS (GENERAL) *

	BASE	HIGH TECHNOLOGY	LOW TECHNOLOGY
Economics (MACRO)	Realistic Projection Series (UCLA)	Stagflation Projection Series (UCLA)	High Growth Economic Projection Series (UCLA)
Hours	Hours Growth Patterns and Sector Ordering as in 72–79	Private Sector Reduced Hours	Government Hours Reduced
		Government Job Hours Relatively High	Private Sector Hours Relatively High
Wages	Wages Increases as in 72–79 Period	High Private Sector Wage Increases Relative to Government Sector	High Government Sector Wage Increases Relative to Private Sector
		High Craft Relative to Technician Wage Increases	High Technician to Craft Wage Increases
Productivity	Growth as in 72–79 Period	High Private Sector Productivity	Relatively High Government Sector Productivity
Technology (Introduction of Equipment/ Jobs)	Growth as in 72–79 Period	High Job Openings Rate	Low Job Openings Rate

*Please note there can be differences for sex groups in the general relationships as shown.

Figure 2

The high growth economic conditions for the best case view present a potentially confusing label which requires clarification. Specifically, a high growth projection builds in low levels of inflation, high gross national product changes and lower than average levels of unemployment for all occupations. The consequences are an opportunity for the government to close any wage gaps due to past cost of living adjustments, higher product value for agricultural/export outputs and services, and less structural and frictional unemployment at all occupation levels. Such conditions can therefore be consistent with a tightening of the federal budget through work effort reductions, private sector hiring of lower skilled workers, increased government sector productivity and fewer than usual technician job openings.

Reservation wage availability rates were projected for three alternative views of technology and the U.S. economy in the period 1980-1985. Such estimates were produced for each sex and minority/non-minority category in middle and senior levels. Three choices were modeled: the non-persistence (loss) decision, the craft journeymen migration (gain) decision, and the private sector transition (loss) decision. An example of the resulting data is provided as Table 1.

It is estimated that if current trends persist, the physical science and engineering technician occupations will continue to be dominated by males through the mid 1980's. Since this occupation is a good candidate for affirmative action, these estimates could be strongly influenced by positive EEO efforts. This includes efforts to increase internal flows

DEPARTMENT OF THE NAVY

PROJECTED WAGE AVAILABILITY BASED LOSS/GAIN RATES

PHYSICAL SCIENCE AND ENGINEERING TECHNICIANS
SENIOR LEVEL (GS 9-12)
MINORITY MALES

YEAR	NON-PERSISTANCE	PRIVATE SECTOR LOSS	GAINS FROM CRAFTS
HISTORICAL PERIOD			
72	.010	.050	.152
73	.022	.050	.155
74	.021	.056	.157
75	.020	.065	.120
76	.027	.083	.116
77	.019	.088	.075
78	.019	.058	.054
79	.021	.057	.071
BASE CASE SCENARIO			
80	.025	.062	.171
81	.027	.072	.159
82	.030	.080	.132
83	.032	.088	.118
84	.035	.097	.099
85	.038	.105	.090
HIGH TECHNOLOGY CASE			
80	.025	.097	.047
81	.028	.102	.132
82	.031	.109	.071
83	.035	.129	.097
84	.038	.140	.043
85	.046	.148	.010
LOW TECHNOLOGY CASE			
80	.025	.055	.176
81	.027	.060	.167
82	.029	.062	.142
83	.030	.066	.127
84	.032	.071	.103
85	.034	.076	.100

TABLE 1

occupations as well as to increase the awareness of women that the physical science and engineering technician occupations have good career potential.

Application to Internal Planning

The econometric estimates for wage avialability based transitions were first compared to actual transition data to evaluate the usefulness of projected estimates in predicting transitions under the three alternative scenarios. It appeared that other factors such as initial population size should also be included. Models were then developed to predict personnel flows based on the numbers of people in the selected categories and estimated wage availability rates for these flows.[6] The projected flows and resulting recruiting requirements for these categories were then produced for the three alternative future scenarios using a standard manpower planning model with embedded personnel flow rates.[7] Results showed increasing recruiting requirements to maintain current strengths under all three scenarios. Embedding the projected flow rates in a manpower planning model also allows consideration of additional constraining factors and managerial strategies in further analysis of these scenarios.

The population used for the internal manpower model in this example consists of nine job categories in the U.S. Navy civilian work force: Entry, mid, senior, and supervisor levels for physical science and engineering technicians; and apprentice, semi-skilled, journeyman, leader, and supervisor levels for blue collar craftsmen. The primary focus is on techncians and their response to technological change in the economy. Craftsmen are included as an important internal source for movement into the technician occupation.

[6] For the model mathematics see D. M. Atwater, E. Bres, III, R. J. Niehaus and J. A. Sheridan (1).

[7] See A. Charnes, W. W. Cooper, and R. J. Niehaus (8) and R. J. Niehaus (9). In this case a goal programming model was used.

The wage availability rates produced by the econometric analysis for flows from mid and senior level technicians to the external economy and for flows from journeyman crafts to mid and senior technicians were used to attempt to predict observed yearly flows over the period 1972-1980. Other factors included the number in a category at the beginning of a year and the number in a category who would be eligible for retirement in a given year. A least absolute value constrained regression approach was used to allow inclusion of constraints on the coefficients and predicted flows.[8]

Inspection of the data and the results of preliminary models showed that the wage availability rates did not move with observed flow rates from the same time period. Models with lagged wage availability rates gave much better results.

The flow rates produced by this model were projected forward through 1987 under the three alternative scenarios. These rates are illustrated for male senior physical science and engineering technicians in Figure 3. Actual and predicted flow rates for the historical period are also indicated. To effect an integration of supply and demand factors these flow rates were used in a standard manpower planning model to determine resulting future hiring requirements. This model requires flow rate estimates for all personnel categories in the chosen population. These rates were simultaneously estimated with a constrained minimum absolute deviation regression where the flow rates previously estimated for wage availability data were fixed at predicted values.

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[8] Constrained regression models were introduced in A. Charnes, W. W. Cooper, and R. Ferguson (5).

Department of the Navy

Acutal and Projected Loss Rates

Senior Level (GS 9-12) Male Physical Science and Engineering Technicians

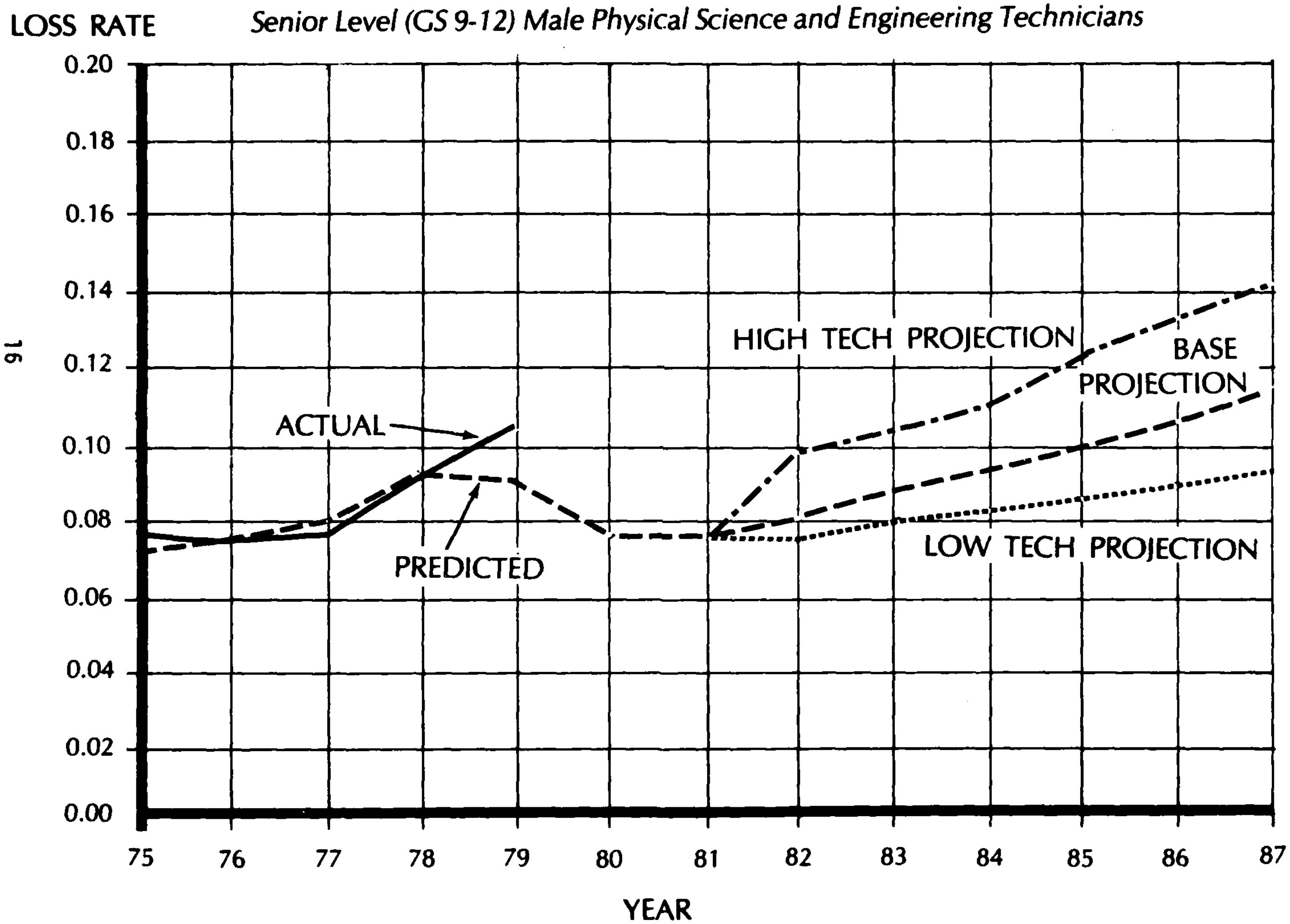

Figure 3

The flow rates produced by this process were then used in the planning model to determine projected annual recruiting requirements for all categories over the 1981-1987 period under the three alternative scenarios. Constant requirements were assumed for this example. These results for mid and senior level male physical science and engineering technicians are shown in Table 2.

The hires for mid-level technicians increase over time by amounts that vary according to the particular scenario, but do not exceed the largest number of hires observed over the five immediately preceding years. However, the senior level male technician hires as shown in Figure 4 show a marked increase over time in response to technological change in the economy, even for the low technology scenario. In all cases the maximum for the preceding five-year period is exceeded.

The impact of technological changes in the economy upon the U.S. Navy's work force could be further assessed by adding hiring constraints to the manpower planning model. These constraints would place an upper bound on number of technicians that could be hired from the outside economy under alternate scenarios. Values for these bounds could be estimated by wage availability and past recruiting success rates. These estimates have not yet been developed. The effect of such an upper bound can be illustrated by choosing an arbitrary bound such as the maximum observed number of hires over the last five years for male senior technicians, 529. With this bound we would have significant shortfalls for senior technicians under the base and high technology scenarios. These shortfalls could be met in part by allowing increased flow from other categories, such as crafts journeymen, into the technician

U. S. DEPARTMENT OF THE NAVY
PROJECTED HIRES (CONSTANT REQUIREMENTS)
PHYSICAL SCIENCE AND ENGINEERING TECHNICIANS

Mid-Level (GS 5-8)

YEAR	BASE CASE	HIGH TECH	LOW TECH
81	331	331	331
82	332	332	332
83	341	372	336
84	351	374	341
85	360	385	347
86	370	405	352
87	381	419	359

Senior Level (GS 9-12)

YEAR	BASE CASE	HIGH TECH	LOW TECH
81	427	427	427
82	404	435	403
83	453	670	403
84	533	743	442
85	605	813	480
86	680	976	528
87	764	1,076	570

Table 2

Department of the Navy

PROJECTED HIRES

(Constant Requirements)

Physical Science and Engineering Technicians Senior Level (GS 9-12) Males)

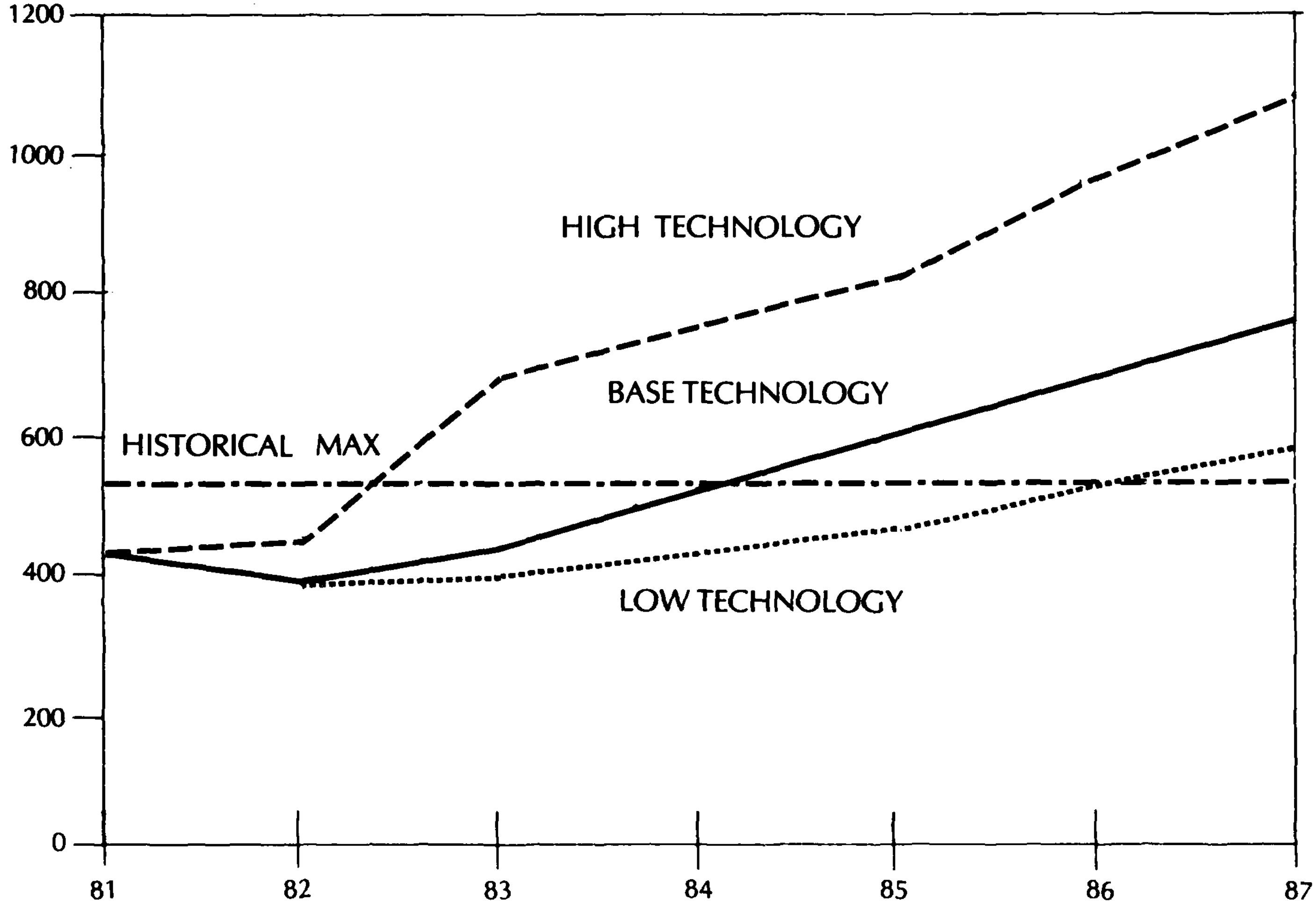

Figure 4

occupation. Increased hires for crafts journeymen would then be required. The manpower planning model could be modified to allow flexible flows between selected categories to evaluate this possibility.[9]

In this case the projected number of crafts journeymen who would be wage available for the technician jobs would provide an upper bound for these flows.

Management Implications

The results produced in the preceding example show a need for the Navy to hire substantially more physical science and engineering technicians during the second half of the 1980's than it has been able to hire in recent years. These results, based on a constant level of requirements, come about because the civilian economy will draw trained technicians out of the Navy through higher wages and other factors such as a shorter work week. The increasing number and complexity of Navy weapon systems will almost certainly cause an increase in requirements for skilled technicians over this time period. As a result the projected shortfall will be even larger than we have indicated. What can Navy management do to fill this gap?

One response to the projected personnel shortage is to contract out the maintenance of high technology weapon systems. This approach can be thought of as an indirect way to pay the higher wage that would have been needed to retain Navy technicians, both civilian and military. While this response allows flexibility in providing a changing balance of needed skills, it is probably more costly than doing the work with Navy employees and military personnel. Morever, the total supply is not increased and wages would be forced even higher with this approach.

[9]See A. Charnes, W. W. Cooper, K. A. Lewis and R. J. Niehaus (6) and A. Charnes, W. W. Cooper, A. Nelson and R. J. Niehaus (7).

Other possible avenues rely on increasing the total supply of qualified technical manpower. These approaches could tap non-traditional sources of technical manpower which might then be trained for the specific skills needed by the Navy. This type of response could also present a positive opportunity to improve the Navy's EEO posture. Examples of non-traditional external sources could include discouraged workers not now in the labor force, persons now retired from other jobs, and women re-entering the labor market. Specially targeted recruitment programs could be required to reach these groups. Clerical, administrative, and blue collar workers could provide sources for internal and external recruitment. The current study, for example, used the wage incentives available to crafts journeymen for transfer to mid and senior level technician jobs in predicting such flows. Data shows that blue collar craftsmen are the largest internal source for technicians. Clerical and administrative personnel appear in the data as sources for lower level technicians and should be included in subsequent studies.

Use of internal recruitment could be considered an expansion of previous upward mobility efforts for persons in low skill and "dead end" occupations. Reliance on internal recruitment would create vacancies in the source occupations, but there would be less problem filling these positions. The HRP model used in this study considers the effects of these internal flows. In this model projected flow rates are fixed at values predicted from wage incentive projections under the alternative scenarios. It is possible to consider the use of internal recruitment in greater detail through use of the flexible flow models developed for Navy HRP and EEO purposes. Such models would determine the flow rates needed to fill technician (or other targeted) jobs through internal recruitment. Incentives would then have to be developed to produce these flow rates.

Specially tailored training programs would be needed to develop the required technical skills for most people recruited from non-traditional sources. Some sources such as retired persons with a technical background would require only limited training, while others such as clerical personnel might require a significant technical education effort. It is possible that the Navy could profit from such training programs, in the long term, even if a payback period were not required for those supplied with training.

Another response to a shortfall in technical personnel would be to restructure the ways that required tasks are combined into jobs: It may be possible to collect the tasks that depend on high levels of technical skills into a smaller number of jobs, with the less critical supporting tasks done by trainee or lower skilled, "para-technical" employees. At least some task restructuring would be required to accommodate trainee personnel brought in from non-traditional sources.

A final response is to restructure the requirement for technical personnel. Planned introduction of new technology might be stretched out over a longer period until the required technical manpower could be found. Weapon systems might be redesigned to simplify the quantity and quality of technical skills required to operate and maintain them. Such efforts may only shift requirements to a different organizational level. For example, automated test procedures built into newer weapon systems may ease organizational maintenance requirements but increase technical skills required for depot level maintenance. Such tradeoffs need to be considered as part of the Navy's response to a technical manpower shortfall.

As was indicated above, the results of this study could be further sharpened by several extensions. The current study looked at the internal supply of technician manpower under several alternative views and compared the recruiting requirements that emerged from the model with hypothetical hiring constraints. Further econometric analysis is needed to project the external labor market supply of technicians. This supply should then be combined with a projected recruiting success rate (also to be estimated) to produce a projected hiring constraint that could easily be incorporated in the model structure. The supply constraint would vary in accordance with the particular scenario chosen. It would also be useful to examine manpower requirements that vary over time in response to alternative technology choices. The approach developed in this study should be useful in evaluating the manpower feasibility of such choices. Finally, the models discussed here could be extended to cover other critical occupations where the Navy may face future shortages. The next section discusses one such application.

Manpower Implications of the 600 Ship Navy

The planned major expansion to a 600 ship, 18 battle group Navy will require substantial increases in civlian support personnel. Specialized skills will be needed at shipyards as aging ships are overhauled to extend service. New construction of ships will also create additional demand for skilled shipyard workers. The decline of the U.S. shipbuilding industry in recent years, an aging workforce at Navy shipyards, and the difficulty of inducing young people entering the blue collar labor market to undertake lengthy crafts training programs all point to a declining supply of skilled manpower able to meet these new requirements. The combination of increased demand and reduced supply may force delays in the Navy's shipbuilding expansion plans. The long lead

times involved in shipbuilding may allow the Navy to take actions to increase the supply of shipyard workers before major bottlenecks appear if projected shortfalls can identified in advance.

A planned expansion in the Navy's aircraft inventory will place similar demands on skilled workers at naval air rework facilities (NARF's). The effects of increased technology application noted above are particularly pertinent in this area. Although the aircraft maintenance cycle may not bring new aircraft into overhaul for several years, service life extension programs for existing aircraft may increase demand in the near term as well, especially if the operating tempo is increased.

The integrated human resources planning model system developed in this study could be applied to the projected supply-demand imbalance questions raised by the Navy's expansion plans. Additional labor market analysis for blue collar craftsmen, physical science and engineering technicians, and other critical occupations would provide estimates for projected internal and external skilled manpower supply. These estimates would be used in internal personnel flow models that determine net recruiting requirements to assess whether the total manpower demands associated with the planned expansion could be met. The analysis of alternatives would follow the pattern discussed in the prevous section. Specific attention could be directed to individual shipyards and NARF's as well as intermediate organizational levels and the all Navy case. The quantitative, as well as qualitative analyses provided by this approach would provide important management information for development of the Navy's expansion plans.

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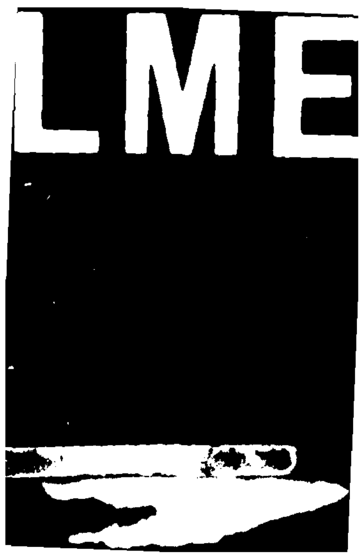
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